BONNEVILLE POWER ADMINISTRATION

backgrounder

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Cracking open the black box of the ocean

Salmon spend most of their lives in salt water. Most don't come back to the river to spawn. If just 1 to 2 percent more juvenile salmon survived to adulthood in the ocean, the number of adult salmon that came back to the Columbia River to spawn would double, National Oceanic and Atmospheric Adminstration Fisheries has estimated. That's because, today, depending on the run, only one-tenth of 1 percent to 2 percent of the salmon who enter the Columbia River estuary as smolts return as adults.

According to NOAA Fisheries and Canadian researchers, there's a strong correlation between the ocean conditions salmon face and adult returns but no correlation between juvenile salmon survival through the hydro system and adult returns. Poor ocean conditions could override the benefits of improved fresh-water habitat and hydro system passage conditions for fish.

Scientists know little about what happens to salmon during their life in the ocean. Salmon management techniques often treat the ocean as a "black box" – a uniformly unknown quantity – and management plans for different stocks do not reflect any differences in habitat the stocks may encounter while in the ocean.

New technologies are allowing scientists to pry up the lid of the ocean's black box and begin to learn what happens to these fish during their life at sea. These efforts could help fish managers tailor salmon management in fresh water to produce the best possible survival prospect for the fish in the ocean and increase the likelihood of their successful return.

What we know: food, temperature and the Pacific Decadal Oscillation

Generally, it appears that more Columbia Basin salmon survive when cold water prevails off the coast of Oregon, Washington and British Columbia. Salmon need cold water. If the ocean warms slightly, salmon survival can be greatly reduced. Possible causes include reduction in food sources, increases in predation and changes to their metabolism.

In 1996, scientists at the University of Washington identified a long-term pattern of cold/warm Pacific

Thirteen runs of Columbia River salmon and steelhead plus resident bull trout and Kootenai River white sturgeon are listed under the Endangered Species Act. The salmon and steelhead listings include nine runs in the mainstem Columbia and Willamette rivers and four in the Snake River. Bull trout populations are listed in several parts of Idaho and Montana.

currents and temperatures that correlates to salmon survival patterns.

Warm eras of this Pacific Decadal Oscillation see higher salmon returns in Alaska and poorer productivity off the West Coast of the contiguous United States, while cold eras produce the opposite effect. This correlation applies equally to rivers with and without dams.

The most recent cold cycle appears to have lasted from 1998-2003, coinciding with vastly improved salmon returns since 2000. Since 2004, water temperatures off the coast of Oregon and Washington have risen and food availability for salmon declined. Scientists now predict poor salmon returns for 2007.

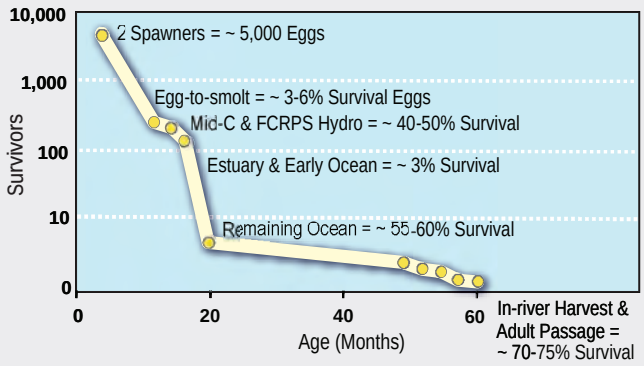
One reason for this effect is coastal upwelling. In the cold-water phase, northern winds pull cold water from the ocean's depths to the surface off Oregon, Washington and British Columbia, bringing an abundance of plankton that feeds the entire food chain. During the

warm phase, upwelling diminishes, reducing food sources for salmon, seabirds, anchovies, sardines, herring and other creatures.

Scientists' tracking of the Pacific Decadal Oscillation also shows a general trend toward warmer seas.

What we're learning

BPA has funded ocean research designed to improve Columbia Basin salmon management and enhance successful recovery of threatened and endangered runs. Here is a synopsis of those studies.



About 40 to 50 percent of chinook smolts now survive passage downstream through the hydroelectric system. In contrast, only 3 to 6 percent of chinook eggs survive to become smolts, and only about 3 percent of those that reach the estuary survive to the later stages of their ocean sojourn.

In the estuary: The Columbia River is influenced by the tide up to Bonneville Dam, so fish managers count everything below that point as estuary. Scientists are increasingly finding that the estuary is important to smolts growth and adjustment to salt water and their subsequent survival. The combination of tides, ocean influences and fresh water makes a complex food web. BPA funds research on the role of the estuary in salmon survival. BPA also funds ecosystem monitoring and habitat restoration in the estuary.

In the plume: The plume is the layer of fresh river water that lies on top of salt water in the estuary and extends into the ocean. It varies greatly in size and shape, depending on winds, tides and river flows. The plume front appears important to salmon survival when they first reach the ocean; murky water may hide them from predators while they adjust to saltwater. BPA funds research on the plume's role in the salmon's life cycle.

In the ocean: Scientists now believe salmon fare better in some parts of the ocean than others. BPA is funding two ocean studies by Canadian researchers through the Northwest Power and Conservation Council's fish and wildlife program.

Pacific Ocean Shelf Tracking Project

This project monitors the movement of marine life along the West Coast of North America. The objective is to understand the survival of various fish stocks in relation to their ocean distribution and migration. It uses new acoustic technology to track individual fish. Salmon are implanted with acoustic tags. Each tag sends out a unique signal picked up by receivers on the ocean floor. Researchers intend to deploy six arrays of receivers from Cascade Head south of the Columbia to Icy Strait off Alaska.

Canada-USA Shelf Salmon Survival Study

This study focuses on coastal waters off British Columbia and Southeast Alaska. It will help scientists identify broad regions of good or poor salmon growth and survival in the ocean and begin defining why growth and survival rates differ among regions. For example, Snake River chinook appear disproportionately abundant in a region of poor ocean growth off Vancouver Island in summer. Other Columbia River stocks, such as the Hanford Reach chinook, have a more northerly ocean distribution that coincides with a region of higher growth.

General migratory pattern of pacific salmon.

How ocean studies can help freshwater fish managers

Understanding what happens to salmon in the ocean will help managers choose the most effective strategies for improving salmon survival in fresh water. For example, hatchery releases could be timed so that salmon arrive in the ocean when food is plentiful. If the migratory behavior of certain stocks exposes them to regions of poor ocean survival, that information can be incorporated in management plans.

The ocean has a significant effect on salmon survival and productivity. It no longer can be seen as a relatively uniform and unchanging environment. Changes in ocean conditions can mask the effectiveness of human efforts to help salmon in fresh water. Where annual changes in salmon survival in fresh water may double or halve, changes in ocean survival may change up to one hundred-fold.

Opening the lid of the ocean's black box and understanding how to address the ocean's vagaries can help fish managers improve the effectiveness of freshwater efforts and improve salmon survival.

For more information

To learn more, go to the following Web sites:

North Pacific Anadromous Fish Commission – *www.npafc.org*

Pacific Ocean Salmon Tracking Project – *www.postcoml.org/*

Lower Columbia River Estuary Program – *www.lcrep.org/*

Bonneville Power Administration – *www.bpa.gov*